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U.S. Department
of Transportation

East Building, PHH-30
1200 New Jersey Avenue S.E.
Washington, D.C. 20590

**Pipeline and Hazardous
Materials Safety Administration**

DOT-SP 16108
(SECOND REVISION)

EXPIRATION DATE: June 30, 2020

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: Carleton Technologies Inc.
Westminster, MD
2. PURPOSE AND LIMITATIONS:
 - a. This special permit authorizes the manufacture, mark, sale and use of non-DOT specification fully wrapped carbon-fiber reinforced, aluminum-lined composite cylinders conforming with ISO Standard 11119-2, except as specified herein, for the transportation in commerce of Division 2.1 and 2.2 hazardous materials. This special permit provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein. The most recent revision supersedes all previous revisions.
 - b. The safety analyses performed in development of this special permit only considered the hazards and risks associated with transportation in commerce. The safety analyses did not consider the hazards and risks associated with consumer use, use as a component of a transport vehicle or other device, or other uses not associated with transportation in commerce.
3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.
4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR § 173.302a(a)(1), 173.304a(a)(1) and 180.205, in that non-DOT specification cylinders are not authorized, except as provided herein.

5. BASIS: This special permit is based on the application of Carleton Technologies Inc. dated June 11, 2016 submitted in accordance with § 107.109.
6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous Material Description			
Proper Shipping Name	Hazard Class/ Division	Identification Number	Packing Group
Air, compressed	2.2	UN1002	N/A
Argon, compressed	2.2	UN1006	N/A
Carbon dioxide	2.2	UN1013	N/A
Compressed gas, n.o.s.	2.2	UN1956	N/A
Compressed gas, oxidizing, n.o.s.	2.2	UN3156	N/A
Helium, compressed	2.2	UN1046	N/A
Heptafluoropropane or Refrigerant gas R 227	2.2	UN3296	N/A
Hydrogen, compressed	2.1	UN1049	N/A
Liquefied gas, oxidizing, n.o.s.	2.2	UN3157	N/A
Methane, compressed or Natural gas, compressed (with high methane content)	2.1	UN1971	N/A
Nitrogen, compressed	2.2	UN1066	N/A
Nitrous oxide	2.2	UN1070	N/A
Oxygen, compressed	2.2	UN1072	N/A
Pentafluoroethane or Refrigerant gas R 125	2.2	UN3220	N/A

July 14, 2016**7. SAFETY CONTROL MEASURES:**

a. PACKAGING - Prescribed packaging is a non-DOT specification fully wrapped, carbon-fiber reinforced 6161-T6 aluminum lined cylinder. Cylinders are limited to a maximum water volume of 315 Liters (19,223 cubic inches), and a service pressure of 517 bar (7,500 psig). Cylinders must be manufactured and marked in conformance with ISO 11119-2 Standard: 2002 ("Gas cylinders of composite construction - Specification and test methods - Part 2: Fully wrapped fibre reinforced composite gas cylinders with load sharing metal liners") except that:

Section 6.2.2 The resin system must be tested on a sample coupon representative of the composite overwrap in accordance with ASTM D-2344-89 for water boil shear test. The minimum shear strength may not be less than 34,474 kPa (5000 psi).

Section 7.2.4 c) The working pressure, p_w (if applicable and which shall not exceed test pressure $\times 3/5$)

b. TESTING - The cylinders must be tested in accordance with the ISO 11119-2 prototype design requirements except that:

Section 8.2.1 Cylinder lot for qualification testing shall represent minimum number of cylinders needed to complete testing. Spare cylinders may be included in the lot at the manufacturer's discretion.

Section 8.2.2 Not applicable

Section 8.2.7 Except for the cases identified in 8.2.8, the inspector shall supervise the following tests on the cylinders selected:

a) hydraulic proof pressure test, in accordance with 8.5.1 or, hydraulic volumetric expansion test, in accordance with 8.5.2;

b) burst test, in accordance with 8.5.4

c) ambient cycle test, in accordance with 8.5.5;

d) environmental cycle test, in accordance with 8.5.6;

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e) flaw test, in accordance with 8.5.7 except: "The flaw shall be made with a 1mm thick cutter to a depth equal to at least 50% of the composite thickness but no greater than 2,5 mm deep, and to a length between the centers of the cutter equal to five times the composite thickness.";

f) drop test, in accordance with 8.5.8;

g) high velocity impact (gunfire) test, in accordance with 8.5.9

h) fire resistance test, if a pressure relief device is fitted to prevent failure in case of a fire in service, in accordance with 8.5.10;

i) salt water immersion test, in accordance with 8.5.11;

j) torque test, in accordance with 8.5.12;

k) high temperature creep test, in accordance with 8.5.13.

Section 8.5.3 *Liner burst test* - Not required.

Section 8.5.4 *Cylinder burst test*. The minimum required burst pressure is 3.4 times the service pressure marked on the cylinder. A minimum of three cylinders must be hydrostatically tested in accordance with the following:

(1) Procedure: Pressurize each cylinder at a uniform rate up to 3.4 times the marked service pressure, and hold at that pressure for a minimum of 60 seconds. The rate of pressurization may not exceed 1,379 kPa (200 psi) per second. Increase the pressure to failure and record the pressure at the onset of failure. Cylinders used in the ambient temperature cycling test may be used for the burst test.

(2) Acceptable test results: In no case may the burst pressure of any cylinder be less than the required minimum burst pressure. The failure initiation must be in the cylindrical part of the

cylinders.

Section 8.5.5 *Ambient cycle test.* At a minimum, two cylinders must be subjected to cycling pressurization tests in accordance with the following:

(1) Procedure: Pressurize the cylinder between a pressure not greater than 10 percent of service pressure and the service pressure at a rate not to exceed 10 cycles per minute. The minimum dwell time in the pressure range between 90 and 100 percent of the service pressure may not be less than 1.2 seconds. Each cylinder must be subjected to a minimum of 10,000 cycles. Following the cycling test to service pressure, each cylinder must be subjected to a minimum of 30 pressurization cycles by pressurizing between approximately zero and the minimum required test pressure. The dwell time between 90 and 100 percent of the maximum test pressure may not be less than 1.2 seconds.

(2) Acceptable test results: Each test cylinder must withstand the cycling pressurization test without any evidence of visually observable damage, distortion or leakage. After successfully passing the cycling test, the cylinder must be burst tested in accordance with the procedure in Section 8.5.4(1) of this special permit. The residual burst strength of the cylinder must be at least 90 percent of the required minimum burst pressure (3.06 times service pressure).

Section 8.5.6 *Environmental cycle test.* Two cylinders shall be cycle tested in accordance with the following:

(1) Procedure: The cycling rate may not exceed 10 cycles per minute. The dwell time between 90 and 100 percent of the maximum test pressure may not be less than 1.2 seconds.

Step 1: Cycle test at ambient temperature by pressurizing from approximately zero pressure to service pressure for 10,000 cycles.

Step 2: Pressurize and maintain the cylinder at service pressure and subject the cylinder

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to a minimum of 20 thermal cycles at each temperature of 93.3°C (200°F) and minus 51.6°C (minus 60°F) maintaining the dwell time at each extreme temperature to a minimum of 10 minutes.

Step 3: After successfully passing the cycling test, the cylinder shall be burst tested in accordance with the procedure in Section 8.5.4 of this special permit.

(2) Acceptable test results: The test cylinder must withstand the thermal cycling test without any evidence of visually observable damage, distortion or leakage. In addition, the residual burst strength of the cylinder must be at least 90 percent of the required minimum burst pressure (3.06 times service pressure).

Section 8.5.8 Drop Test. At a minimum, one empty cylinder, complete with valve (or equivalent) but uncharged must be subjected to a drop test from a height of 3 meters (10 feet) onto a concrete surface in accordance with the following:

(1) Procedure:

Drop 1: The cylinder shall be dropped vertically onto the end.

Drop 2: The cylinder shall be dropped horizontally onto the sidewall.

Drop 3: The cylinder shall be dropped horizontally onto a 3.8 x 0.48 cm (1 ½ x 3/16 inch) piece of angle iron, with the included angle in the downward position. The cylinder shall land at right angles to and on the heel edge of the angle iron, impacting approximately in the center of the sidewall.

(2) Acceptable results:

If one cylinder tested: The cylinder must be subjected to 1,000 pressure cycles from not greater than 10 percent of service pressure and the service pressure at a rate not to exceed 10 cycles per minute. The minimum dwell time in the pressure range between 90 and 100 percent of the service pressure may not be less than 1.2 seconds. The test cylinder must withstand the cycling

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pressurization test without any evidence of visually observable leakage or damage growth during or after the pressure cycle test. After successfully passing the cycling test, the cylinder must be burst tested in accordance with the procedure described in 8.5.4. The residual burst strength of the cylinder must be at least 90 percent of the required minimum burst pressure (3.06 times service pressure). The cycling and burst pressure test data must be submitted to the DOT for the information database. The failure initiation does not have to be in the cylindrical part of the cylinder.

If two cylinders are tested: One cylinder must be subjected to 1,000 pressure cycles from not greater than 10 percent of service pressure and the service pressure at a rate not to exceed 10 cycles per minute. The minimum dwell times in the pressure range between 90 and 100 percent of the service pressure may not be less than 1.2 seconds. The test cylinder must withstand the cycling pressurization test without any evidence of visually observable leakage or damage growth during or after the pressure cycle test. After successfully passing the cycling test, the cylinder must be burst tested. The rate of pressurization may not exceed 1,379 kPa (200 psi) per second. Increase the pressure to failure and record the pressure at the onset of failure. The burst pressure must be recorded. The other cylinder must be burst tested in accordance with the procedure described in 8.5.4. The residual burst strength of the cylinder must be at least 90 percent of the required minimum burst pressure (3.06 times service pressure). The cycling and burst pressure test data for both cylinders must be submitted to the DOT for the information database. The failure initiation does not have to be in the cylindrical part of the cylinders.

Section 8.5.9 High velocity impact(gunfire) test. One cylinder must be tested in accordance with the following:

- (1) Procedure: The cylinder must be charged with air or nitrogen to service pressure and shall be impacted by a 0.30 caliber armor piercing

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projectile having a velocity of about 853.4 meters (2800 feet) per second. The cylinder shall be positioned in such a way that the impact point shall be in the cylinder sidewall at an angle of 45° to the longitudinal axis of the cylinder and aimed to exit the sidewall on the opposite side of the cylinder. The distance from the firing location to the cylinder may not exceed 45.7 meters (150 feet).

(2) **Acceptable test results:** The cylinder shall not fail by fragmentation. The approximate size of the entrance and exit penetrations shall be recorded.

Section 8.5.10 Fire resistance test.

Two cylinders must be tested in accordance with the following:

(1) **Procedure:** Cylinders are to be equipped with a valve fitted with a bursting disc in compliance with the requirements in 49 CFR 173.301(f). Cylinders must be charged with nitrogen or air to service pressure. The required bonfire test procedure shall be in accordance with the Compressed Gas Association (CGA) Pamphlet CGA C-14-1992. The test shall be performed with the cylinder placed in an upright position. The cylinder shall be exposed to fire until the contents are fully vented.

(2) **Acceptable test results:** The venting of the gas must be predominantly through the pressure relief device. Cylinders must be intact at the completion of venting.

Section 8.5.11 Salt water immersion test - Not required.

Section 8.5.12 Torque test. The torque test is not required. However:

(1) Threads must be clean cut, even, without checks, and must be designed in compliance with the requirements of the Federal Standard FED-STD-H28, Appendix A5.

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(2) Tapered threads are not permitted.

(3) Straight threads having at least 6 threads must have a calculated factor of safety in shear of at least 10 at the test pressure for the cylinder. The threads must extend completely through the neck.

Section 8.5.13 *High temperature creep test* - Not required.

c. BATCH TESTING -

Section 9.1.2 The liner hardness test is not required.

Section 9.1.3 The liner burst test is not required.

Section 9.4.5 One cylinder (randomly selected) from each lot of completed cylinders must be subjected to cyclic pressurization testing in accordance with the following:

(A) Procedure: The cylinder shall be cycled to service pressure in accordance with 8.5.5 of this special permit. Adequate recording instrumentation must be provided if the test is expected to run unattended for any period of time exceeding two hours.

(B) Acceptable test results: Test results must be in accordance with 8.5.5 of this special permit.

Section 9.5.1 In the event of failure to meet test requirements either during a production run (batch test) or when design type approval tests do not give satisfactory results, an investigation into the cause of failure and re-testing shall be carried out. When a cylinder fails a batch acceptance test, five additional cylinders selected randomly may be subjected to the same test. If all five cylinders pass, the lot may be accepted. If one or more of the cylinders fails, the lot must be rejected.

d. MARKING - The cylinders must be marked in accordance with 49 CFR § 178.71(p) except that the marking must contain the special permit number "DOT-SP 16108" in lieu of the ISO Standard. Except cylinder weight is not required to be marked on the cylinder.

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e. REQUALIFICATION - Cylinders must be reinspected and hydrostatically retested at least once every five years. Testing must be performed in accordance with §180.205, tested to 5/3 of the marked service pressure and the latest edition of CGA Pamphlet C-6.2 "Guidelines for Visual Inspection and Re-qualification of Fiber Reinforced High Pressure Cylinders", except as specifically noted herein:

(1) Cylinders must be volumetrically tested by the water jacket method suitable for the determination of the cylinder expansion for a minimum test time of one minute.

(2) Reinspection markings must be applied on a label securely affixed to the cylinder and over-coated with epoxy, near the original test date. Metal stamping of the composite is prohibited. Reheat treatment of rejected cylinders is not authorized.

(3) Cylinders with fiber damage (cuts, abrasions, etc.) that exceeds Level 1 type damage as defined in CGA Pamphlet C-6.2 and meet the following depth and length criteria are considered to have Level 2 damage:

(i) Depth - Damage that upon visual inspection is seen to penetrate the outer fiberglass layer but does not expose the carbon layer beneath, or that has a measured depth of greater than 0.005 inch and less than 0.045 inch for cylinders with an outside diameter greater than 7.5 inches or less than 0.035 inch for cylinders 7.5 inches or less in outside diameter;

(ii) Length - Damage that has a maximum allowable length of:

Region	Direction of fiber damage	Maximum length of damage
Cylinder sidewall and domes	Transverse to fiber direction (longitudinal direction)	20% of the straight sidewall section length
Cylinder sidewall and domes	In fiber direction (circumferential direction)	20% of the straight sidewall section length

(4) Cylinders with damage that meets the Level 2 criteria must be rejected. Retesters must contact the cylinder manufacturer in the event that the damage cannot be clearly interpreted based on these criteria. Repair of rejected cylinders is authorized for Level 2 type damage. Repairs must be made in accordance with CGA Pamphlet C-6.2, prior to the hydrostatic pressure test. Repairs must be evaluated after the hydrostatic test.

(5) Cylinders that have direct fiber damage that penetrates through the outer fiberglass layer and into the carbon layer, or that have a measured damage depth of greater than the Level 2 maximum are considered to have Level 3 type damage. Cylinders that have damage with depth meeting Level 2, but length exceeding the Level 2 maximum, are considered to have Level 3 type damage. Cylinders with Level 3 type damage are not authorized to be repaired, and must be condemned.

(6) Persons who perform inspection and testing of cylinders subject to this special permit must comply with § 180.205(b) and with all the terms and conditions of this special permit.

(7) Hydrostatic retest may be repeated as provided for in §180.205(g), only two such retests are permitted. Pressurization prior to the official hydrostatic test for the purpose of a systems check must not exceed 85% of the minimum required test pressure.

f. OPERATIONAL CONTROLS -

(1) Cylinders manufactured under this special permit are not authorized for use in underwater applications.

(2) Any cylinder exhibiting evidence of fire or excessive heat damage may not be retested under the terms of this special permit.

(3) Cylinders manufactured under this special permit are not authorized for use fifteen (15) years after the date of manufacture.

(4) Transportation of oxygen is only authorized when in accordance with § 175.501.

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(5) Cylinders must be packaged in accordance with § 173.301(a)(9).

8. SPECIAL PROVISIONS:

a. In accordance with the provisions of Paragraph (b) of § 173.22a, persons may use the packaging authorized by this special permit for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this special permit.

b. A person who is not a holder of this special permit, but receives a packaging covered by this special permit, may reoffer it for transportation provided no modification or change is made to the packaging and it is offered for transportation in conformance with this special permit and the HMR.

c. A current copy of this special permit must be maintained at each facility where the package is offered or reoffered for transportation.

d. Each packaging manufactured under the authority of this special permit must be either (1) marked with the name of the manufacturer and location (city and state) of the facility at which it is manufactured or (2) marked with a registration symbol designated by the Office of Hazardous Materials Special Permits and Approvals for a specific manufacturing facility.

e. A current copy of this special permit must be maintained at each facility where the packaging is manufactured under this special permit. It must be made available to a DOT representative upon request.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor Vehicle, Cargo aircraft, Cargo Vessel, Passenger-carrying aircraft for military applications only, Rail Freight.

10. MODAL REQUIREMENTS: A current copy of this special permit must be carried aboard each cargo vessel, aircraft or motor vehicle used to transport packages covered by this special permit. The shipper must furnish a copy of this special permit to the air carrier before or at the time the shipment is tendered.

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11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this special permit and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

- o All terms and conditions prescribed in this special permit and the Hazardous Materials Regulations, 49 CFR Parts 171-180.
- o Persons operating under the terms of this special permit must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.
- o Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this special permit must receive training on the requirements and conditions of this special permit in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this special permit, including display of its number, when this special permit has expired or is otherwise no longer in effect.

Under Title VII of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—"The Hazardous Materials Safety and Security Reauthorization Act of 2005" (Pub. L. 109-59), 119 Stat. 1144 (August 10, 2005), amended the Federal hazardous materials transportation law by changing the term "exemption" to "special permit" and authorizes a special permit to be granted up to two years for new special permits and up to four years for renewals.

12. REPORTING REQUIREMENTS: Shipments or operations conducted under this special permit are subject to the Hazardous Materials Incident Reporting requirements specified in 49 CFR §§ 171.15 Immediate notice of certain hazardous materials incidents, and 171.16 Detailed hazardous materials

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incident reports. In addition, the grantee(s) of this special permit must notify the Associate Administrator for Hazardous Materials Safety, in writing, of any incident involving a package, shipment or operation conducted under terms of this special permit.

Issued in Washington, D.C.:



for Dr. Magdy El-Sibaie

Associate Administrator for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Pipeline and Hazardous Material Safety Administration, U.S. Department of Transportation, East Building PHH-30, 1200 New Jersey Avenue, Southeast, Washington, D.C. 20590.

Copies of this special permit may be obtained by accessing the Hazardous Materials Safety Homepage at http://hazmat.dot.gov/sp_app/special_permits/spec_perm_index.htm Photo reproductions and legible reductions of this special permit are permitted. Any alteration of this special permit is prohibited.

PO: CWFreeman/SG